August 2017

Roots, and corn silage for fattening lambs

W. J. Kennedy
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E. T. Robbins
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EXPERIMENT STATION

IOWA STATE COLLEGE
OF AGRICULTURE AND MECHANIC ARTS

ANIMAL HUSBANDRY SECTION

ROOTS, AND CORN SILAGE FOR FATTENING LAMBS

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SUMMARY OF BULLETIN 110

These experiments include three years’ work with considerable duplication so that the results should indicate fairly well the economic importance of roots and corn silage for winter fattening of lambs. The following conclusions appear to be well supported by the facts brought out by these experiments:

1. Succulent feed in the ration for fattening lambs had the effect of increasing their appetite for grain, although it decreased the amount of hay consumed.

2. The lambs never ate more than 2 pounds of silage daily per head when getting a full feed of corn. Five to 6 pounds of beets or mangels were eaten under similar conditions.

3. The dry fed lambs made slow gains at first, but later gains were much more rapid, comparing quite favorably in the last months with the gains put on with mangels and beets, and surpassing those made with other succulent feeds.

4. In each of the three years the lambs getting sugar beets made the largest total gain and matured more quickly than any of the other lambs. They also carried a better bloom and finish.

5. Sugar beets and mangels favored the formation of renal calculi, or stones in the kidneys and bladder, with the possibility of an obstructed urethra and consequent fatal results to rams long fed on these feeds.

6. So far as finish was concerned all the rations produced market topping lambs so that the value of the feeds to the shepherd depended more on the rate and economy of the gains they produced.

7. The amount of dry matter required for each 100 pounds gain was highest for the lots getting turnips and cabbage, and lowest for those getting mangels and sugar beets. Silage and dry feed occupied an intermediate position. In one case the advantage was with silage and in another with dry feed.

8. The lambs fed succulent feed suffered a shrink of from 1 to 4 pounds per head more than the dry fed lambs in shipping to Chicago.

9. Financially, dry feed produced more economical gains than roots of any kind when corn was at ordinary prices. During the first year, when corn and silage were low in price, silage gave the cheapest gains, with dry feed second.
ROOTS AND CORN SILAGE FOR FATTENING LAMBS

W. J. KENNEDY. E. T. ROBBINS. H. H. KILDEE.

OBJECTS OF THE EXPERIMENTS

To throw some light on the subject of succulence for winter fattening of lambs, with especial reference to the use of corn silage in that capacity, a series of experiments was conducted during three winters, beginning December, 1906. These experiments were planned to indicate the principal results attending the feeding of succulent feed to fattening lambs and to furnish a comparison between the old time special crops for this purpose, and corn silage, the only succulent feed practicable for winter use on an extensive scale. The immediate objects of the work were as follows:

1. To compare a ration of grain and hay for fattening lambs with rations containing succulent feed.
2. To compare sugar beets, mangels, turnips, rutabagas, cabbage, and corn silage as sources of succulence for fattening lambs.
3. To determine whether succulent feed is essential to rapid gains, high condition, and quality of finish.

PLAN

Each experiment was begun in the fall when the lambs were taken off the pastures and put in dry yards for fall and winter feeding. Four lots were fed each year for three successive years. One lot of each group was fed dry feed alone, consisting of grain and hay, while the other three lots had the same grain and hay with succulent feed in addition. The principal attention was given to sugar beets, mangels, and corn silage as sources of succulence. They yield better than turnips and rutabagas and keep better in storage than cabbage. The lambs were given all the succulent feed they desired, and in the first two years work they were pushed forward rapidly
from the start with a heavy feed of grain for the purpose of fattening them quickly. In the last year's work they were fed only a light feed of grain at the start and a longer time was taken for finishing them. This was done so as to make a large use of the hay and succulent feed.

The first year the lambs were pushed to the limit of their capacity. They were fed alfalfa, hay and a grain mixture of corn, oats, bran, and oil meal in the proportions of 5, 2, 2, 1 by weight to give them the best possible bloom and finish. This was done to test the value of these feeds as compared with succulence for the production of this extra quality and condition.

The second year corn alone was used as a grain feed and the hay was of poorer quality so as to give conditions more like those on the ordinary farm. The hay was mixed timothy and clover the first month, largely alfalfa the second, and mostly poorly cured and partially molded cow pea hay the third and last month. The proportions by weight of the several kinds of hay were approximately 1, 1, 2, respectively. The third year corn alone constituted the grain ration for four months. Then cottonseed meal was introduced and gradually increased during the last two months until it was being fed at the rate of 25 pounds cottonseed meal to every 75 pounds of corn. The hay this last year was of very poor quality as all the best hay on hand was fed to the horses and cattle.

The first year seven lambs were fed in each of the 4 lots, from December 28, 1906, to April 19, 1907, a total of 112 days time. The following season nine lambs were included in each of 4 lots, and fed from September 11, 1908, to February 26, 1909, a total of 168 days' time. Altogether 104 lambs were fed in 12 lots.

**THE LAMBS**

The lambs were for the most part descended by the first or second cross from common western and Merino ewes bred to Leicester, Shropshire, and Southdown rams. All the lambs used in 1906 and in 1907 were bred and raised at the Experiment Station. Records were kept of their breeding, birth, weights, ages, and gains, so that at the time the feeding experiments were begun there was at hand very complete information which was
of valuable assistance in securing an equal division of the lambs into lots both with respect to their appearance and their probable inherent capacity for gains. Less was known with regard to the ancestry and early gains of the lambs used in 1908, but the division into lots in this case was made as equable as possible. This last year only ram lambs were used; the other two years wethers and ewes were fed together. In each experiment the lambs were divided into as even lots as possible with regard to size, form, condition, breed, sex, fleece, age, apparent thrift, and previous gains so far as these were known.

**FEEDS**

The grains were in every case of as good quality as the crops of that year afforded. Corn varied in maturity and moisture content from year to year but was otherwise of good quality. The hay used the first year was third crop alfalfa of fairly good quality. The second

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
<th>Distance apart of rows</th>
<th>Yield per Acre</th>
<th>Cost per Acre</th>
<th>Cost per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1906</td>
<td>Mangels</td>
<td>18</td>
<td>23</td>
<td>$69.00</td>
<td>$3.00</td>
</tr>
<tr>
<td></td>
<td>Sugar beets</td>
<td>18</td>
<td>20</td>
<td>70.00</td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>Corn silage</td>
<td>42</td>
<td>15</td>
<td>37.50</td>
<td>2.50</td>
</tr>
<tr>
<td>1907</td>
<td>Sugar beets</td>
<td>30</td>
<td>14</td>
<td>65.00</td>
<td>4.65</td>
</tr>
<tr>
<td></td>
<td>*Turnips</td>
<td>30</td>
<td>5</td>
<td>66.50</td>
<td>13.30</td>
</tr>
<tr>
<td></td>
<td>Rutabagas</td>
<td>30</td>
<td>10</td>
<td>66.50</td>
<td>6.50</td>
</tr>
<tr>
<td></td>
<td>Cabbage</td>
<td>30</td>
<td>15</td>
<td>57.00</td>
<td>3.80</td>
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<tr>
<td>1908</td>
<td>Mangels</td>
<td>30</td>
<td>17</td>
<td>51.00</td>
<td>3.00</td>
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<td>Sugar beets</td>
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<td>15</td>
<td>52.50</td>
<td>3.50</td>
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<tr>
<td></td>
<td>Corn silage</td>
<td>42</td>
<td>12</td>
<td>36.00</td>
<td>3.00</td>
</tr>
</tbody>
</table>

* A partial failure due to late drought.
all raised especially for this experiment. A careful record of the cost of production and the yield per acre was kept. The first crop of roots was sown in drills 18 inches apart, necessitating hand cultivation exclusively. The yields were large, but the amount of hand labor was so great as to be a forbidding item to most farmers. The next two years the rows were made 30 inches apart to permit cultivation with the intention of cheapening the cost per acre even if the yields were not so large. The following list shows the yield per acre of the several crops and the cost per acre and per ton:

In 1907 the season was wet at first and weeds were troublesome, so the expense for hand work was high in spite of the wide rows. The conditions in 1906 and in 1908 were more nearly alike and the smaller yield from wide rows was just offset by the cheaper cultivation. Corn for the silo was not charged at actual cost of pro-

### TABLE 2 PERCENTAGE COMPOSITION OF FEEDS

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<thead>
<tr>
<th></th>
<th>Water</th>
<th>Ash</th>
<th>Protein</th>
<th>Crude Fiber</th>
<th>Nitrogen Free Extract</th>
<th>Fat</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>10.65</td>
<td>1.29</td>
<td>11.94</td>
<td>4.01</td>
<td>67.28</td>
<td>4.83</td>
</tr>
<tr>
<td>Oats</td>
<td>6.04</td>
<td>3.55</td>
<td>11.01</td>
<td>12.19</td>
<td>61.49</td>
<td>5.72</td>
</tr>
<tr>
<td>Bran</td>
<td>6.28</td>
<td>6.33</td>
<td>13.91</td>
<td>14.21</td>
<td>56.17</td>
<td>3.10</td>
</tr>
<tr>
<td>Oil meal</td>
<td>5.27</td>
<td>5.40</td>
<td>31.20</td>
<td>9.82</td>
<td>41.68</td>
<td>6.03</td>
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<tr>
<td>Mangels</td>
<td>87.42</td>
<td>0.98</td>
<td>1.64</td>
<td>0.81</td>
<td>8.99</td>
<td>0.16</td>
</tr>
<tr>
<td>Sugar beets</td>
<td>86.40</td>
<td>0.21</td>
<td>1.51</td>
<td>3.25</td>
<td>8.54</td>
<td>0.09</td>
</tr>
<tr>
<td>Corn silage</td>
<td>69.80</td>
<td>1.23</td>
<td>2.05</td>
<td>5.98</td>
<td>19.96</td>
<td>0.98</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>4.43</td>
<td>7.26</td>
<td>18.87</td>
<td>24.16</td>
<td>42.73</td>
<td>2.55</td>
</tr>
<tr>
<td><strong>1907</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>15.69</td>
<td>1.62</td>
<td>9.03</td>
<td>1.43</td>
<td>69.81</td>
<td>2.42</td>
</tr>
<tr>
<td>Turnips</td>
<td>90.16</td>
<td>1.06</td>
<td>1.75</td>
<td>1.38</td>
<td>5.38</td>
<td>0.27</td>
</tr>
<tr>
<td>Rutabagas</td>
<td>87.58</td>
<td>1.83</td>
<td>1.93</td>
<td>2.03</td>
<td>5.98</td>
<td>0.65</td>
</tr>
<tr>
<td>Sugar beets</td>
<td>84.94</td>
<td>1.23</td>
<td>1.57</td>
<td>1.36</td>
<td>10.75</td>
<td>0.15</td>
</tr>
<tr>
<td>Cabbage</td>
<td>91.05</td>
<td>0.93</td>
<td>2.25</td>
<td>1.50</td>
<td>3.88</td>
<td>0.39</td>
</tr>
<tr>
<td>Mixed hay</td>
<td>6.82</td>
<td>6.64</td>
<td>8.87</td>
<td>41.58</td>
<td>33.67</td>
<td>2.42</td>
</tr>
<tr>
<td><strong>1908</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>15.80</td>
<td>1.03</td>
<td>7.75</td>
<td>1.13</td>
<td>69.94</td>
<td>4.35</td>
</tr>
<tr>
<td>Mangels</td>
<td>84.22</td>
<td>1.00</td>
<td>1.32</td>
<td>.93</td>
<td>12.36</td>
<td>1.17</td>
</tr>
<tr>
<td>Sugar beets</td>
<td>83.62</td>
<td>.30</td>
<td>1.22</td>
<td>1.38</td>
<td>13.39</td>
<td>0.09</td>
</tr>
<tr>
<td>Corn silage</td>
<td>63.75</td>
<td>2.18</td>
<td>2.83</td>
<td>12.11</td>
<td>18.23</td>
<td>0.89</td>
</tr>
<tr>
<td>Mixed hay</td>
<td>6.60</td>
<td>7.21</td>
<td>7.24</td>
<td>28.35</td>
<td>47.85</td>
<td>2.75</td>
</tr>
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</table>

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duction, but at the price it was worth per acre based upon its estimated yield of grain. Corn is a staple cash crop in Iowa. It would not pay to put it in silo unless the returns would be at least as great as if it were husked. The other crops could only be figured at their actual cost since they had no definite market value. The price per ton quoted for silage includes a small profit to the grower when corn is a paying crop, as it was in the years of these tests. The price per ton of the other crops represents barely their cost of production. This gives the root crops and cabbage an unfair advantage in the comparison unless these facts are borne in mind in studying the results.

The feeds were all analyzed by Louis G. Michael, Experiment Station Chemist. Table 2 gives the analyses.

FEEDING AND MANAGEMENT

The lambs of each lot were confined in rather close quarters with a shed for shelter. The first two years each lot had a yard 40x80 feet to run in for exercise. Those fed in 1908 also had this opportunity for exercise during the first two months. After that, each lot was confined in a stall 16x16 feet under an open shed. They were fed always twice daily, half the daily ration being given at each feeding time. When the lambs were being pushed for quick fattening the grain allowance was made as large as they would eat up immediately after feeding. In all cases after the lambs were first fully accustomed to their succulent feed it was fed in as large quantities as they could handle. Occasionally when the lambs were fed heavily on grain the amount of mangels and beets had to be slightly restricted to prevent scours, but usually they could be given all they would eat. Hay was fed to the limit of their appetites for it. They were charged with the whole amount given, although there was usually a small amount of coarse stems and trash that was not eaten.

FEED CONSUMED

The average daily ration per lamb in 28-day periods and for the whole feeding period; as well as the total
LOT 1. Seven lambs, fed grain, hay, and mangels. Average weight April 19, 1907, 127.8 pounds; weight of fleece April 20, 9.8 pounds. Daily gain for 112 days, 0.44 pounds.
amount of feed given per lamb in the whole time, is shown in Table 3.

The largest amount of grain eaten in any one month was 2.43 pounds daily per lamb by those getting mangels and sugar beets the first season. They were receiving the mixed grain ration of corn, oats, bran, and oil meal in proportion of 5, 2, 2, 1 by weight, with a good quantity of hay, all of which seemed to stimulate their appetites. The first two years most nearly represented the results to be expected where lambs are being fattened. In the third year they were not heavily fed during the first two months, but simply carried along to let them make the greatest possible use of the roughage and succulent feed. In 1906 and 1907 the dry fed lambs never rose to quite as high a consumption of grain as the lambs getting succulent feed, but in 1908 the dry fed lambs ate more during the sixth month than any of the others would take.

This was apparently because the hay fed this last month was of poorer quality than that before given to the lambs.

<table>
<thead>
<tr>
<th>TABLE 3 AVERAGE DAILY RATIONS AND TOTAL FEED PER LAMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1906</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rations in 29 day Periods</th>
<th>Ration 112 Days</th>
<th>Total Feed per Lamb 112 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 28 to Jan. 25</td>
<td>Dec. 28 to Apr. 19</td>
<td>Dec. 28 to Apr. 19</td>
</tr>
<tr>
<td>Mar. 22 to Apr. 19</td>
<td>Mar. 22 to Apr. 19</td>
<td>Mar. 22 to Apr. 19</td>
</tr>
<tr>
<td>Dec. 28 to Apr. 19</td>
<td>Dec. 28 to Apr. 19</td>
<td>Dec. 28 to Apr. 19</td>
</tr>
</tbody>
</table>

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in any experiment. It was stacked hay two years old and badly damaged. The lambs would eat very little of this hay and while those getting succulent feed relied on the same to furnish bulk to the ration, the dry fed lambs ate additional grain in preference to so much hay. From the first two years results, when conditions were entirely normal, it appears that the succulent feed in the ration for fattening lambs had the effect of increasing their appetite for grain, although it decreased the amount of hay consumed.

In general, the amounts of grain and hay eaten by the lambs during the whole feeding period were about equal. Of silage the lambs never ate more than 2 pounds daily per head when getting a full feed of corn, and the average was about 1.5 pounds. Even then they did not eat the

<table>
<thead>
<tr>
<th>Lot</th>
<th>Feeds</th>
<th>Rations in 28 day Periods</th>
<th>Ration 84 Days</th>
<th>Total Feed Per Lamb 84 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nov. 15 to Dec. 13</td>
<td>Dec. 13 to Jan. 10</td>
<td>Jan. 10 to Feb. 12</td>
</tr>
<tr>
<td>8</td>
<td>Corn</td>
<td>1.22</td>
<td>1.51</td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td>Mixed hay</td>
<td>1.34</td>
<td>1.24</td>
<td>.43</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>.86</td>
<td>2.03</td>
<td>.43</td>
</tr>
<tr>
<td></td>
<td>Cow-pea</td>
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<td>3.39</td>
<td>.76</td>
</tr>
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<td>6</td>
<td>Corn</td>
<td>1.21</td>
<td>1.52</td>
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<td></td>
<td>Mixed hay</td>
<td>1.30</td>
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<td>5</td>
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<td>1.22</td>
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<td>Sugar beets</td>
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<td>1.22</td>
<td>2.12</td>
</tr>
<tr>
<td></td>
<td>Alfalfa hay</td>
<td>.86</td>
<td>1.87</td>
<td>.73</td>
</tr>
<tr>
<td></td>
<td>Cow-pea hay</td>
<td>.82</td>
<td>1.87</td>
<td>.73</td>
</tr>
<tr>
<td>7</td>
<td>Corn</td>
<td>1.22</td>
<td>1.53</td>
<td>1.68</td>
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<tr>
<td></td>
<td>Cabbage</td>
<td>2.05</td>
<td>2.39</td>
<td>1.69</td>
</tr>
<tr>
<td></td>
<td>Mixed hay</td>
<td>1.30</td>
<td>1.17</td>
<td>.33</td>
</tr>
<tr>
<td></td>
<td>Alfalfa hay</td>
<td>.86</td>
<td>1.87</td>
<td>.73</td>
</tr>
<tr>
<td></td>
<td>Cow-pea hay</td>
<td>.82</td>
<td>1.87</td>
<td>.73</td>
</tr>
</tbody>
</table>
very coarsest bits of stalk. If more was fed they left uneaten much that they should not have wasted. Of beets and mangels 5 to 6 pounds was a maximum daily feed. Their capacity for each of these roots was quite similar. They ate the sugar beets with a little keener relish but

TABLE 3 (Con.)

1908

<table>
<thead>
<tr>
<th>Feeds</th>
<th>Rations in 28 day Periods</th>
<th>Ration 168 Days</th>
<th>Total Feed per Lamb 168 days</th>
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</thead>
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<tr>
<td></td>
<td>1</td>
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</tr>
<tr>
<td>12</td>
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<tr>
<td>Corn ..........</td>
<td>.89</td>
<td>1.01</td>
<td>1.30</td>
</tr>
<tr>
<td>Cottonseed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>meal ..........</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mixed hay</td>
<td>1.68</td>
<td>2.20</td>
<td>2.47</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
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<tr>
<td>Corn ..........</td>
<td>.91</td>
<td>1.01</td>
<td>1.30</td>
</tr>
<tr>
<td>Cottonseed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>meal ..........</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed hay</td>
<td>1.23</td>
<td>1.63</td>
<td>2.03</td>
</tr>
<tr>
<td>Silage ..........</td>
<td>1.34</td>
<td>1.73</td>
<td>1.88</td>
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<tr>
<td>10</td>
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<tr>
<td>Corn ..........</td>
<td>.87</td>
<td>.99</td>
<td>1.30</td>
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<tr>
<td>Cottonseed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>meal ..........</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mixed hay</td>
<td>1.30</td>
<td>1.64</td>
<td>2.10</td>
</tr>
<tr>
<td>Sugar beets</td>
<td>2.06</td>
<td>3.91</td>
<td>4.80</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Corn ..........</td>
<td>.84</td>
<td>1.00</td>
<td>1.30</td>
</tr>
<tr>
<td>Cottonseed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>meal ..........</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mixed hay</td>
<td>1.36</td>
<td>1.79</td>
<td>1.98</td>
</tr>
<tr>
<td>Mangels ......</td>
<td>1.98</td>
<td>3.94</td>
<td>4.80</td>
</tr>
</tbody>
</table>

seldom ate larger quantities of them than the mangel-fed lambs ate of their mangels. Turnips were not so readily eaten as the other roots. Of cabbage the lambs ate a large bulk but the weight was less than that of mangels or beets. The turnips and cabbage did not keep as well as the other roots so they were not as choice toward the last as at the first.
WEIGHTS AND GAINS

Table 4 gives the weights of the lambs at the start and at the end of each test with their average daily gains for the separate 28-day periods and for the whole time. The dry-fed lambs made slow gains at first, but later their gains were much more rapid, comparing quite favorably in the last months with the gains put on with mangels and sugar beets and surpassing those made with other kinds of succulent feed. The poor keeping qualities of turnips, rutabagas, and cabbages, make them unadapted for winter feeding. The main effect of the succulent feed on

TABLE 4 WEIGHTS AND GAINS OF LAMBS IN POUNDS PER LOT.

1906

<table>
<thead>
<tr>
<th>Lot</th>
<th>Kind of Succulent Feed</th>
<th>Avg'ge Weight at B'gin'g Dec. 28</th>
<th>Daily Gains per Lamb in Periods</th>
<th>Av. for 112 Days</th>
<th>Total Gain per Lamb</th>
<th>Average Final Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mangels ...</td>
<td>78.7</td>
<td>Dec. 28 to Jan. 25</td>
<td>0.25</td>
<td>0.52</td>
<td>0.50</td>
</tr>
<tr>
<td>2</td>
<td>Sugar beets and mangels</td>
<td>77.6</td>
<td>Jan. 25 to Feb. 22</td>
<td>.33</td>
<td>.63</td>
<td>.41</td>
</tr>
<tr>
<td>3</td>
<td>Silage ...</td>
<td>78.4</td>
<td>Feb. 22 to Mar. 22</td>
<td>.35</td>
<td>.46</td>
<td>.34</td>
</tr>
<tr>
<td>4</td>
<td>None ...</td>
<td>79.6</td>
<td>Mar. 22 to Apr. 19</td>
<td>.15</td>
<td>.26</td>
<td>.43</td>
</tr>
<tr>
<td></td>
<td>All lots...</td>
<td>78.6</td>
<td></td>
<td>.26</td>
<td>.47</td>
<td>.42</td>
</tr>
</tbody>
</table>

1907

<table>
<thead>
<tr>
<th>Lot</th>
<th>Kind of Succulent Feed</th>
<th>Avg'ge Weight at Begin'g Nov. 15</th>
<th>Daily Gain per Lamb</th>
<th>Av. for 84 Days Nov. 15- Feb. 7</th>
<th>Total Gain per Lamb</th>
<th>Average Final Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>None .................</td>
<td>68.7</td>
<td>Nov. 15 to Dec. 13</td>
<td>0.28</td>
<td>0.33</td>
<td>0.39</td>
</tr>
<tr>
<td>6</td>
<td>Turnips ..............</td>
<td>67.4</td>
<td>Dec. 13 to Jan. 10</td>
<td>.26</td>
<td>.31</td>
<td>.35</td>
</tr>
<tr>
<td>5</td>
<td>Sugar beets .........</td>
<td>67.7</td>
<td>Jan. 10 to Feb. 7</td>
<td>.39</td>
<td>.46</td>
<td>.38</td>
</tr>
<tr>
<td>7</td>
<td>Cabbage ..............</td>
<td>68.6</td>
<td></td>
<td>.31</td>
<td>.30</td>
<td>.29</td>
</tr>
<tr>
<td></td>
<td>All lots.............</td>
<td>68.1</td>
<td></td>
<td>.31</td>
<td>.35</td>
<td>.35</td>
</tr>
</tbody>
</table>
The gains made the first year show what may be expected of lambs under heavy feeding. The average gains were from 0.37 pounds daily on dry feed to 0.45 pounds with sugar beets. The supply of beets was exhausted during the third month and mangels were fed for the rest of the time. It is doubtful if the gains would have been larger on sugar beets, since in the third year's work the mangel-fed lambs made fully as rapid gains after the first three months as those getting sugar beets. In the second year with corn alone for grain the daily gains were from 0.30 pounds where cabbage or turnips were fed, to 0.41 pounds with sugar beets, while the gains made on dry feed were intermediate at 0.33 pounds daily. Turnips and cabbage seem to have been of little value in the ration at any time so far as rapidity of gains were concerned. The third year on a long feed with a light grain ration at the first, but with cottonseed meal fed with the corn at the last two months, the gains were quite small at first. Later when corn was fed more heavily the gains of all lots improved and during the last two months on corn and cottonseed meal were very good. The average result in gains amounted to 0.29 pounds daily for corn silage, 0.30 pounds, for dry feed, 0.37 pounds for mangels, and 0.39 pounds for sugar beets. Thus in each of the three years the lambs getting sugar beets made the largest total gain, and reached weights of from 1 to 13 pounds.
greater per lamb in the 84 to 168 days feeding than any of the other lambs.

**INDIVIDUALITY OF THE LAMBS**

A record was kept of each lamb's gains as shown by individual weights at the end of each four-week period coinciding with the period for which the feed is given separately. For the first two years especially the lambs in the several lots all made remarkably uniform gains. The variations in each lot were very small, so there seems to be no possible doubt that the differences observed between the lots were caused by the differences in feed. In the third year the lambs were a more variable and less thrifty bunch at the start. Many were evidently suffering from stomach worms and some had tape worms. Still their gains showed that the division of the lambs had been quite fortunate, as the lots were very uniform in gaining capacity. For the most part the variations between the extremely fast and the very slow gaining lambs of each lot were quite narrow.

Only two lambs in the entire three years' experiments gave results that were far below the average. Both of these were included in the last year's test, one in the dry fed lot and one in the silage fed lot. Each of these gained less than half the average of its lot and remained stunted, thin and unthrifty in appearance until the last. For this reason it seems only fair to all rations to bear in mind that both dry feed and silage have probably a slightly greater value for the production of gains than the figures indicate for 1908. At most the discrepancy due to this cause cannot be more than 4.5 to 5 per cent of the gains. Since other lambs in the mangel and in the sugar beet fed lots started out very poorly it is possible that the beneficial effects of these succulent feeds was all that was needed to give these thin, weak lambs the necessary start to thrifty feeding. It seems plausible that this may have been the case and that this greater uniformity of gains of these root-fed rams was one of the direct benefits of the mangels and the beets. In all the tests it was found that some of the best individuals at the start and at the close of a test made only moderate gains, while some of the poorest individuals made exceptionally good gains.
LOT 2. Seven lambs, fed grain, hay, sugar beets, and mangels. Average weight April 19, 1907, 127.7 pounds; weight of fleece, April 20, 9.2 pounds. Daily gain for 112 days 0.45 pounds.
HEALTH OF THE LAMBS*

During the first two years' test the lambs all remained healthy until the last. During the last year's work a careful study was made of the possible operation of sugar beets and mangels in the formation of renal calculi or bladder stones. For this purpose all the lambs used in 1908-09 were rams, since owing to their long restricted urethra it is well recognized by shepherds that the effect of stones in the bladder is more often fatal to them than to ewes. The rams were started on their several rations early in the fall as soon as mangels and beets were fairly mature, so as to get a long feeding period, and the grain ration was kept down to moderate proportions at first to allow a larger use of the roots.

After five months' feeding one sugar beet ram died from the effects of retention of urine, owing to stoppage of the urethra. Before the lambs were marketed at the end of another month's feeding another sugar beet fed ram and one mangel fed ram had died from the same cause. When the rams were marketed a careful examination revealed the fact that all the sugar beet and mangel fed rams showed marked pathological affection of the kidneys and bladder. The kidneys were slightly enlarged and soft and with loose capsule and there were occasional hemorrhagic areas in both the kidneys and the bladder. The latter was enlarged and thickened. Some of these rams also were found to have calculi. The sugar beet rams were more markedly affected than those fed mangels. None of the dry fed rams nor the silage fed rams were thus affected even in the slightest degree. The gains made by the rams were evidently not influenced by this condition, as some of those affected were among the best gaining and thriftiest appearing rams until finally stricken with the obstruction of the urethra. The evidence is very conclusive that sugar beets and mangels favored the formation of renal calculi with the possibility of fatal results to rams long fed on these feeds. Flock owners need to exercise caution in this respect.

CONDITION AND QUALITY OF FINISH

In the first year especially when the lambs were fed for the distinct purpose of producing the very best quality

*See Ia, Bulletin 112, "The Influence of Feeding Sugar Beets and Mangels to Breeding Animals, with Special Reference to the Formation of Renal and Urinary Calculi."

http://lib.dr.iastate.edu/bulletin/vol9/iss110/1
LOT 3. Seven lambs, fed grain, hay, and corn silage. Average weight April 19, 1907, 125.8 pounds; weight of fleece April 20, 10.2 pounds; daily gain for 112 days 0.42 pounds.
of finish, a very careful study was made of this point, including for that year detailed notes of each lamb’s type, form, and condition at the start and at the end, with photographs at the end showing each lamb in the fleece and out of it. The lambs of each lot that year took on a splendid finish and while there was some difference between the lots, all sold at top prices for heavy lambs in Chicago —prices, by the way, which were lower than prices for smaller lambs. The lot fed mangels had a little the best bloom, and the thickest, evenest covering of firm flesh; with the dry fed lot second, the silage fed lot third, and the lot started on sugar beets and finished with mangels fourth. It is impossible to say whether or not the change from beets to mangels that had to be made with the last lot was responsible for any of this lack of bloom. Doubtless it did them no good. The most interesting thing is the fact that the dry fed lambs were so near the top in their condition and quality at the end of the test. They had fattened so well that an English shepherd experienced in feeding and showing mutton sheep was inclined to place these dry fed lambs ahead of the mangel fed lambs without knowing the rations fed to any of them.

The second year the lambs all attained a good finish, so uniform for the several lots that although sold separately on the Chicago market each lot brought the same figure, $6.75, which was a little below the top price for lambs, because they were too big for the trade. The finish was really best on those fed turnips and cabbage. These lots were very much on a par.

The last year of the test the sugar beet fed lambs were again the best in the end, followed by those fed mangels second, dry fed third, and silage fed fourth. The lambs fed sugar beets were distinctly the best in finish, but it was rather close between the other three lots, especially the last two. The lambs fed dry feed alone and those fed silage were of excellent quality except that they lacked the degree of fat carried by the sugar beet fed lambs.

Taking the three years’ work as a whole, sugar beets were found to have a distinct advantage in producing an early finish by means of the rapid gains they produced. Dry feed alone put on fat nearly as fast as sugar beets with dry feed, but on the dry feed alone there was a slower gain and less growth. For the most part the
LOT 4. Seven lambs, fed grain and hay. Average weight April 19, 1907. 120.9 pounds; weight of fleece April 20, 9.1 pounds; daily gain for 112 days. 0.37 pounds.
condition and quality of finish was best where the gains had been smallest. There seemed to be no appreciable direct affect of the feeds on the carcass, at least nothing that was detected by careful examination of the animals alive and dressed. So far as show character was concerned, where early maturity was an important item, the lambs that made the fastest gains were the best, as they combined size with thick flesh of smooth quality.

FEED REQUIRED FOR 100 POUNDS GAIN

It is difficult to compare lambs fed dry feed and those fed some succulent feed so far as raw feed requirements for 100 pounds gain are concerned. While it is interesting from an economic point of view to know the weights of grain and hay required for 100 pounds gain, the efficiency of the several rations in the animal system is more clearly shown by a study of the weights of dry matter for 100 pounds gain. It should be noticed in passing that although the dry fed lambs required a relatively large amount of grain for each 100 pounds gain at the start as shown in Table 5, toward the finish they made more economical use of their grain than the lambs getting succulent feed. Both in 1906 and in 1907 the amount of grain required for 100 pounds gain toward the last by lambs on dry feed was less than for those getting any form of succulent feed.

In dry matter for 100 pounds gain the succulent feed also showed up to best advantage in the first months of the feeding period, especially when sugar beets or mangel:s supplied this material. Dry feed showed up poorly at first but was quite economical later on, so that for the last month of the test in each year the dry matter required by the dry fed lambs for each 100 pounds gain was really less than that required where succulent feed was given. For the whole time, however, the amount of dry matter in the dry feed per 100 pounds gain was higher than in the mangel and sugar beet rations, higher in one case and lower in another than the dry matter for 100 pounds gain with silage, but lower than for turnips and cabbage. The lowest amount of dry matter per 100 pounds gain for a period of some length was 757 pounds.
TABLE 5  FEED AND COST PER 100 POUNDS GAIN.

1906

<table>
<thead>
<tr>
<th>Lot</th>
<th>Feeds</th>
<th>112 Days</th>
<th></th>
<th></th>
<th></th>
<th>Nutritive Ratio</th>
<th>Cost per 100 lbs. Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grain</td>
<td>440</td>
<td>396</td>
<td>463</td>
<td>501</td>
<td>450</td>
<td>1:4.2</td>
</tr>
<tr>
<td></td>
<td>Mangels</td>
<td>498</td>
<td>778</td>
<td>1,213</td>
<td>1,226</td>
<td>986</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>646</td>
<td>211</td>
<td>238</td>
<td>402</td>
<td>357</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry matter</td>
<td>1,083</td>
<td>739</td>
<td>804</td>
<td>998</td>
<td>878</td>
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<td></td>
<td>Total cost per cwt. gain</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>$6.82</td>
</tr>
<tr>
<td>2</td>
<td>Grain</td>
<td>332</td>
<td>326</td>
<td>508</td>
<td>588</td>
<td>443</td>
<td>1:4.2</td>
</tr>
<tr>
<td></td>
<td>Sugar beets</td>
<td>375</td>
<td>699</td>
<td>878</td>
<td>518</td>
<td>518</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mangels</td>
<td>507</td>
<td>218</td>
<td>290</td>
<td>469</td>
<td>346</td>
<td></td>
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<td></td>
<td>Alfalfa</td>
<td>840</td>
<td>602</td>
<td>1,000</td>
<td>1,168</td>
<td>868</td>
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<tr>
<td></td>
<td>Dry matter</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>$6.86</td>
</tr>
<tr>
<td>3</td>
<td>Grain</td>
<td>353</td>
<td>449</td>
<td>668</td>
<td>412</td>
<td>463</td>
<td>1:4.2</td>
</tr>
<tr>
<td></td>
<td>Silage</td>
<td>402</td>
<td>409</td>
<td>436</td>
<td>158</td>
<td>327</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>535</td>
<td>282</td>
<td>326</td>
<td>369</td>
<td>367</td>
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</tr>
<tr>
<td></td>
<td>Dry matter</td>
<td>956</td>
<td>805</td>
<td>1,056</td>
<td>778</td>
<td>874</td>
<td></td>
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<tr>
<td></td>
<td>Total cost per cwt. gain</td>
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<td></td>
<td></td>
<td></td>
<td>$5.90</td>
</tr>
<tr>
<td>4</td>
<td>Grain</td>
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<td>747</td>
<td>485</td>
<td>376</td>
<td>511</td>
<td>1:3.7</td>
</tr>
<tr>
<td></td>
<td>Alfalfa</td>
<td>1,150</td>
<td>588</td>
<td>323</td>
<td>347</td>
<td>464</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry matter</td>
<td>1,780</td>
<td>1,246</td>
<td>753</td>
<td>676</td>
<td>912</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total cost per cwt. gain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$6.33</td>
</tr>
</tbody>
</table>

...for sugar beet fed lambs in 84 days’ feeding. None of the lots required on an average as much as 1,000 pounds of dry matter for 100 pounds gain when they were heavily fed throughout the fattening period as in 1906 and 1907.

**SHIPPING AND SLAUGHTERING**

Since the last year’s lambs were included in an investigation into the causes and processes of the formation of...
TABLE 5 (Con).

1907

<table>
<thead>
<tr>
<th>Periods of 28 Days</th>
<th>Nutritive Ratio</th>
<th>Cost per 100 lbs. Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 15 to dec. 13</td>
<td>Dec. 13 to Jan. 10</td>
<td>Jan. 10 to Feb. 7</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>Corn</td>
<td>433</td>
</tr>
<tr>
<td></td>
<td>Mixed hay</td>
<td>476</td>
</tr>
<tr>
<td></td>
<td>Alfalfa hay</td>
<td>376</td>
</tr>
<tr>
<td></td>
<td>Cow-pea hay</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Dry matter</td>
<td>793</td>
</tr>
<tr>
<td></td>
<td>Total cost per cwt. gain</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Corn</td>
<td>433</td>
</tr>
<tr>
<td></td>
<td>Turnips</td>
<td>482</td>
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<td>Mixed hay</td>
<td>498</td>
</tr>
<tr>
<td></td>
<td>Alfalfa hay</td>
<td>387</td>
</tr>
<tr>
<td></td>
<td>Cow-pea hay</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Dry matter</td>
<td>886</td>
</tr>
<tr>
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<td>Total cost per cwt. gain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sugar beets</td>
<td>314</td>
</tr>
<tr>
<td></td>
<td>Mixed hay</td>
<td>562</td>
</tr>
<tr>
<td></td>
<td>Alfalfa hay</td>
<td>312</td>
</tr>
<tr>
<td></td>
<td>Cow-pea hay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry matter</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Total cost per cwt. gain</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Corn</td>
<td>389</td>
</tr>
<tr>
<td></td>
<td>Cabbage</td>
<td>674</td>
</tr>
<tr>
<td></td>
<td>Mixed hay</td>
<td>412</td>
</tr>
<tr>
<td></td>
<td>Alfalfa hay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cow-pea hay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry matter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total cost per cwt. gain</td>
<td></td>
</tr>
</tbody>
</table>

renal calceuli, they were slaughtered locally to facilitate the examination of parts of their carcasses in the laboratory study in this connection. The lambs fed the first two years were shipped to Chicago and each lot sold on its merits on the open market. The lambs sold the first year

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were slaughtered in Chicago and their dressed weights were obtainable. The data secured regarding the shrink in shipping and the dressed weight are given in Table 6.

In 1906, with the shorn lambs the shrink in shipping was very heavy, although the lambs were fed timothy hay and a slightly reduced grain ration including some oats for two days before shipping. The wooled lambs the next year made a much more reasonable shrink but were fed and handled in the same way in preparing them for shipping. Very probably the removing of the fleece three days before the lambs of 1906 were shipped made them shrink worse during the chilly night in the car. The dry
feed was a distinct advantage when it came to shipping the lambs. Those fed succulent feed lost in transit from 1 to 4 pounds per head.

**TABLE 6 SHIPPING AND SLAUGHTER. AVERAGE PER LAMB.**

<table>
<thead>
<tr>
<th>Kind of Succulent Feed</th>
<th>Selling Price per cwt.</th>
<th>Home Weight Pounds</th>
<th>Chicago Weight Pounds</th>
<th>Shrink in Shipping per cwt.</th>
<th>Dressed Wt.</th>
<th>Suet Fat p'cent of Live Wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mangels</td>
<td>$7.35</td>
<td>118.0</td>
<td>104.6</td>
<td>11.4</td>
<td>57.7</td>
<td>55.2</td>
</tr>
<tr>
<td>S. beets</td>
<td>7.35</td>
<td>118.3</td>
<td>105.7</td>
<td>10.7</td>
<td>57.1</td>
<td>54.0</td>
</tr>
<tr>
<td>Silage</td>
<td>7.33</td>
<td>115.4</td>
<td>101.4</td>
<td>12.1</td>
<td>55.8</td>
<td>55.0</td>
</tr>
<tr>
<td>None</td>
<td>7.33</td>
<td>111.8</td>
<td>101.1</td>
<td>9.5</td>
<td>52.5</td>
<td>51.9</td>
</tr>
<tr>
<td>(3) S. beets</td>
<td>6.75</td>
<td>102.1</td>
<td>97.0</td>
<td>5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Turnips</td>
<td>6.75</td>
<td>93.1</td>
<td>88.0</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Cabbage</td>
<td>6.75</td>
<td>94.0</td>
<td>87.0</td>
<td>7.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) None</td>
<td>6.75</td>
<td>96.8</td>
<td>94.0</td>
<td>2.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*In 1906 the lambs were shorn before shipping.*

As mentioned before, all the lambs satisfied the requirements of the trade as prime lambs on the Chicago market except that each year they were too heavy for the needs of the trade. In 1906, when the dressed weights were secured, the lambs fed succulent feed all gave about the same percentage of dressed weight—about 55 per cent. The dry fed lambs scarcely dressed 52 per cent. If the percentage of dressed weight had been figured on the basis of the live weight before shipping the difference between the dry fed lambs and the others would be about 1.5 per cent instead of 3 per cent. The light shrink of the dry fed lambs is a distinct advantage to the seller, but undoubtedly results in a light percentage of dressed weight as well.

**FINANCIAL STATEMENT**

Table 5 indicates together with the amount of feed required for each 100 pounds gain in weight of the lambs, an itemized statement of the cost of feed for each 100 pounds gain. The prices of feed used at the time of these tests were as follows:
In Table 7 we have grouped for convenient comparison the cost of feed for three years of the experiments. The first year the cheapest gains were made with the use of silage, while sugar beets were most expensive. The second year, when silage was not tried, dry feed gave the cheapest gains, with sugar beets more economical than either turnips or cabbages. These two latter crops did not yield heavily enough in proportion to the expense of raising to prove cheap feed; and besides, they were not as palatable as sugar beets and did not produce as rapid gains on the lambs. The great cost of gains, combined with poor keeping qualities, were deemed sufficient grounds for dropping turnips and cabbage from further tests.

| Table 7 Prices of Feeds |

<table>
<thead>
<tr>
<th>Year</th>
<th>1903</th>
<th>1907</th>
<th>1908</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn per bushel</td>
<td>$0.32</td>
<td>$0.35</td>
<td>$0.50</td>
</tr>
<tr>
<td>Oats per bushel</td>
<td>$0.32</td>
<td>$0.35</td>
<td>$0.50</td>
</tr>
<tr>
<td>Bran per ton</td>
<td>$19.00</td>
<td>$19.00</td>
<td>$19.00</td>
</tr>
<tr>
<td>Oil meal per ton</td>
<td>$31.00</td>
<td>$31.00</td>
<td>$31.00</td>
</tr>
<tr>
<td>Cottonseed meal per ton</td>
<td>$3.00</td>
<td>$3.00</td>
<td>$3.00</td>
</tr>
<tr>
<td>Mangels per ton</td>
<td>$3.50</td>
<td>$4.05</td>
<td>$3.50</td>
</tr>
<tr>
<td>Sugar beets per ton</td>
<td>$2.50</td>
<td>$2.50</td>
<td>$2.50</td>
</tr>
<tr>
<td>Corn silage per ton</td>
<td>$6.65</td>
<td>$3.80</td>
<td>$3.00</td>
</tr>
<tr>
<td>Turnips and rutabagas per ton</td>
<td>$9.00</td>
<td>$8.00</td>
<td>$6.00</td>
</tr>
</tbody>
</table>

The third year with 50 cent corn and $3 silage, sugar beets and dry feed gave the cheapest gains, both at the same figure. Mangels and silage followed in the order named. With lower corn and silage, say 32 cent corn and $2.50 silage, as in 1906, the dry feed and silage would have given more nearly the same cost of gains and both would have been considerably cheaper than beets and mangels.

Judging by the indifferent appetite for silage shown by the lambs, it seems that to this fact must be ascribed in large part its poorer relative results as compared with
mangels and beets for the long feeding period when considerable dependence was placed upon the succulent part of the ration for the gains. Dry feed showed up on the whole to remarkably good advantage, proving more economical than roots of any kind when corn was at ordinary prices. Silage also gave cheaper gains than roots of any kind when corn and silage were low priced. It must be remembered, too, that the prices of silage allow a small profit to the grower, while the root crops were figured at the actual cost of raising. The cash value of the corn crop in Iowa operates to make the price of silage appear relatively high as compared with roots, whereas the latter have but a nominal cash value over most of the state and when they are raised the land is not returning a profit. This consideration, in the light of the uncertain economy of root crops in the ration even when they were figured at actual cost, precludes them from proving worthy of consideration by the average feeder to whom cheapness of gains is more important than rapidity. Even for the short period with very heavy feeding following in 1906, the silage fed lambs made cheaper gains than any fed roots, and cheaper than those getting dry feed alone.
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